S P E C I F I C A T I O N

SYSTEMS AND METHODS FOR A MULTI-PLATFORM WIRELESS MODEM

BACKGROUND OF THE INVENTION

Related Applications

This application claims benefit under 35 U.S.C. §119 of United States Provisional Application Serial No. 60/273,760, filed March 5, 2001, which is incorporated herein by reference, and this application is related to co-pending United States Application entitled "SYSTEMS AND METHODS FOR A MULTI-PLATFORM WIRELESS MODEM", Application Serial No. TBD (Attorney Docket No. 262/286)

Field of the Invention

[001] The present invention relates generally to wireless data communication and, more particularly, to systems and methods for a multi-platform wireless modem.

Background

[002] Wireless communication and portable computing are converging. As a result, many portable computing devices incorporate a wireless modem for data communication. A wireless modem uses wireless communication channels to replace a more traditional wired connection through, for example, a telephone or a cable line. Also, in order to meet an increased demand for wireless data communication, wireless system operators have developed a variety of data communication protocols to support wireless data

communication within their systems. Unfortunately, this has resulted in a plurality of incompatible data communication systems and protocols.

[003] The plurality of systems and protocols creates problems for wireless modem manufacturers, because a wireless modem manufacturer must design a different modem for each communication system and/or protocol. Making matters worse for the manufacturer, different portable computing devices may require the wireless modem to have a specific form factor. Each portable computing device may also define a different software protocol for communication between the computing device and the wireless modem. As a result, the wireless modem manufacturer may have to design a different wireless modem assembly for each type of communication protocol and each type of portable computing device. The duplication creates excess cost for the manufacturer and makes changing or upgrading modems difficult for the user.

[004] For purposes of this specification and the claims that follow, the term wireless communication protocol is used to refer to both the air interface standard used by the wireless modem to access a communication channel in a particular communication system and to the communication protocol used by devices in the system to communicate with each other. Common air interface standards include Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), as defined for example by the IS-136 specification, Global System for Mobile (GSM) communications, and Code Division Multiple Access (CDMA) as defined for example by the IS-95 specification. There is also a world wide effort to consolidate the different wireless communication protocols into a single standardized protocol known as third generation or "3G".

[005] Despite efforts to achieve convergence in the so-called 3G communication protocols, however, there is still considerable confusion in the market-place. The confusion is made worse by numerous proprietary, non-standard protocols in use in a variety of systems, and even when a standard protocol is used differences in implementation between offerings from multiple modem vendors, or between those from a single vendor, make transitioning between vendors and/or technologies difficult for the end user. As a result, the concept of seamless replacement is not available to the end user or system integrator, which results in added cost, frustration, and delayed time-to-market, as well as reduced competitiveness in the market place.

SUMMARY OF THE INVENTION

[006] In order to combat these problems, the systems and methods for a multi-platform wireless modem provide for standardization of a wireless modem in several key areas as well as the ability to seamlessly configure the wireless modem to implement different communication protocols and/or air interface standards.

[007] Some key areas of standardization include: a standard form factor, a standard core module that comprises a baseband section and an RF section, a standard software protocol for communication between the wireless modem and a host device, a standardized interface between the standard core module and the host device, and standard methods for power management.

[008] Configurability is achieved by configuring the core module to be removable. This way, the wireless modem can be configured for different communication protocols and/or air interface standards by removing and replacing the core module. Additionally, certain

aspects of the software protocol and the power management methods are left undefined so that they can be customized for a particular implementation.

[009] Further features and advantages of this invention as well as the structure of operation of various embodiments are described in detail below with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[010] The forgoing aspects and many of the attendant advantages of this invention will become more readily appreciated by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

[011] Figure 1 is an example embodiment of a wireless modem assembly in accordance with the invention;

[012] Figure 2 is an example RF transceiver that can be included in the wireless modem assembly of Figure 1;

[013] Figure 3 is an example embodiment of a baseband section that can be included in the wireless modem assembly of Figure 1;

[014] Figure 4 is an example embodiment of a wireless modem assembly that includes a wireless interface device;

[015] Figure 5 is an example embodiment of the wireless interface device of Figure 6; and

[016] Figure 6 is an example embodiment illustrating serial data communication interfaces between a wireless modem and a host device in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

1. Standard Core Module

[017] Figure 1 illustrates a wireless modem assembly 100 in accordance with the systems and methods for a multi-platform wireless modem. Assembly 100 comprises a core module 102 and an interface 112 for interfacing assembly 100 to a host device 114 in which assembly 100 is installed or with which assembly 100 is connected. Core module 102 can further comprises SIM card support 116, RF section 104 having antenna connector 108, and baseband section 106 configured to support one or more advanced features 110, explained in detail below.

[018] The systems and methods for a multi-platform wireless modem provide a future-proofed multi-technology, multi-platform strategy that provides standardization across the following primary areas:

- Physical form-factor;
- Standard host interface;
- Software protocol;
- RF connection, including support for future antenna technologies; and
- Power management.

[019] The standardization is achieved through the combination of core module 102 and interface 112. Interface 112 is preferably configured to provide a standard interface between assembly 100 and host device 114. This greatly simplifies the complexity of designing a core module 102, because it can be designed for one standard interface, regardless of the type of host device 114. Interface 114 is discussed more fully below.

[020] Core Module 102 also preferably enables standardization in terms of different end-user form-factors, different user interfaces, and different host platforms as well as standardization across different communication protocols. Such standardization is achieved using cross-technology standardization principles in the design of different core modules 102 intended for different applications. By incorporating these principles into the design of different core modules 102, they preferably become interchangeable. Therefore, a single wireless modem assembly 100 can easily be configured for different environments by simply swapping out one core module 102 for another. For example, if wireless modem assembly 100 is switched form a Cellular Digital Packet Data (CDPD) environment to an Enhanced Data GSM Environment (EDGE) environment, all that is needed is to switch core module 102 from a CDPD module to an EDGE module.

[021] This standardization, however, goes beyond designing each core module 102 so that it can plug into the same socket or connector in assembly 100. For example, each module 102 is preferably configured to communicate over a standard interface 112 as opposed to each module 102 being configured for a device specific interface. As will be explained below, standardization of interface 112 also preferably requires that the software communications protocols used to communicate over interface 112 be standardized. Therefore, each core module 102 only needs to be configured to support one communication protocol for communicating with host device 114. The standardization principles further include future-proofing provisions designed to enable backward-compatible customizations for future modules with smaller form-factors, that supports new wireless communication protocols, and that support greater power (current)

requirements, new software features, future antenna technologies, future power management features/algorithms, etc. Therefore, future wireless modem assemblies 100 can reduce the impact and cost of migrating to a new technology, form factor, etc., by being configured to use core modules 102.

[022] As described above the standardization principles address the shortcomings of current solutions by permitting migration from one communication protocol or technology to another via removal of one core module 102 and simple replacement with another module 102. The physical replacement of a core module 102 will generally require a host software protocol upgrade to accommodate new or enhanced features and/or protocols specific to a given host device 114, and may require an increase in power (current) supplied to assembly 100. Such changes are generally recognized to be significantly easier than a redesign of the physical interface to support different form-factors, features, possibly connectors, etc., which is required by conventional migration techniques

[023] Moreover, the standardization described allows the manufacturer to significantly streamline his manufacturing efforts, thus providing significant costs savings. Essentially, the manufacturer can build one standard wireless modem assembly 100 instead of a different assembly 100 for each different application. The manufacturer will then need to build different core modules 102 as required for different applications. But by implementing the standardization principles described, variations in the manufacturing process for these different modules 102 is minimal. Thus, overall manufacturing cost are reduced. Moreover, in some embodiments, the standardization in design of core modules

102 allows a wireless modem assembly 100 to be reconfigured for a different application via software reconfiguration of core module 102, which enables such advantages as over the air reconfiguration of assembly 100.

[024] In order to facilitate replacement of core module 102, assembly 100 preferably includes a standard connector or socket (not shown) configured to receive core module 102. This, of course, requires that core module 102 include the correct type of interface in terms of both hardware and software for interfacing with the standard connector. Core module 102 also preferably conforms to a standard form factor. This allows the use of a standard connector as discussed. It also is another factor in easing migration from technology to technology or from one type of host device 114 to another.

[025] RF Section 104 and baseband section 106 are discussed in detail in the following sections. RF section 104 is responsible for interfacing wireless modem assembly 100 to other devices over a wireless communication channel. Baseband section 106 is responsible for communicating information from host device 114 to those other devices, and vice versa, once assembly 100 is connected to them over the communication channel. In the sections that follow various other aspects of assembly 100 are discussed, with specific attention to how the design of assembly 100 is standardized in accordance with the systems and methods described herein.

a. The RF Section

[026] RF section 104 comprises a transceiver used to transmit and receive RF signals over a wireless communication channel in accordance with the appropriate air interface standard. An example transceiver 200 is illustrated in figure 2. Transceiver 200 is split

into a transmit and receive path. The transmit path comprises a modulator 202 that modulates baseband signals from baseband section 106 (see Figure 1) with an RF carrier 204 in order to generate an RF transmit signal. RF carrier 204 is a sinusoidal carrier signal with a frequency equal to that required by the communication channel used by modem assembly 100 to communicate with other devices. The transmit path of transceiver 200 may also include a Power Amplifier (PA) 206. PAs are typically key components in any high frequency RF transmitter design. This is because RF transmitters typically require high output power to compensate for path losses and to achieve satisfactory signal levels at the antenna connected to antenna connector 108 (see Figures).

[027] The receive path of transceiver 200 comprises a demodulator 208 that modulates a received RF signal with RF carrier 204 in order to remove the carrier and extract the baseband information signal. The receive path may also include a Low Noise Amplifier (LNA) 210. The RF signals received by the antenna are typically at very low signal levels. Therefore, a LNA 210 is used to amplify the signal level, but not introduce noise that could swamp the low level received signal.

[028] The receive and transmit paths are typically duplexed over a common connection, e.g., antenna connector 108, to the antenna 216. The impedance of the connection, however, needs to match the impedance of the antenna for the antenna to transmit the RF transmit signal efficiently. If the impedance is not matched, then RF energy will be reflected back in the opposite direction when a transmit or receive RF signal reaches the connection. Therefore, a matching network 212 can be included in order to match the

impedance between the connection and the antenna. Typically, for example, the connection will have impedance of 50 ohms. Therefore, the matching network needs to adjust the impedance of the antenna to be reasonably close to 50 ohms at the signal frequency.

[029] RF section 104 also includes an antenna connection 108 for connecting wireless modem assembly 100 to whatever antenna is being used. As part of the standardization principles discussed above, antenna connection 108 is preferably a standard connector used for all air interface standards that assembly 100 can be configured to implement. This significantly reduces design complexity by allowing a standard connector to be selected for all possible configuration of assembly 100, which saves manufacturing time and cost. It also allows for easy reconfiguration of assembly 100 by simply installing the appropriate core module 102 and the appropriate antenna. Moreover, depending on the implementation, it can also allow for module 102 to be reconfigured for a different air interface via a software reconfiguration and installation of the appropriate antenna into connector 108. This ability substantially streamlines the manufacturing process and even allows for reconfiguration of assembly 100 in the field.

[030] Differences in air interface standards and in host devices, however, can make it difficult to have a common antenna connection for all possible configurations of assembly 100. These differences require that in some instances, a different antenna type must be used depending on the configuration. Differences in antenna types prevent the use of a standard connector for several reasons. First, direct antenna connections are generally custom designed for the specific antenna type. Second, different antennas will

require different tuning, which will not only impact the type of connector, but can also impact the design of RF section 104. Moreover, regulatory requirements for some host devices preclude using a standard connector for all configurations. Preferably, however, wireless modem assembly 100 comprises an antenna connector 108 that is reusable for as many configurations as possible, thus permitting the use of a broad range of antenna solutions including internal, external, and patch antennas. Further, with the advent of third generation (3G) wireless systems, it may be even more practical to use a common antenna and therefore a common antenna connector 108.

[031] Regardless of what connector is used, it is also preferable for assembly 100 to have a standard location for antenna connector 108 in accordance with the standardization principles discussed. In this manner, design time and cost can be saved. Moreover, a set location ensures that antenna connector 108 does not interfere with the ability to reconfigure a particular wireless modem assembly 100 for a new Wireless communication protocol and/or air interface standard. In one embodiment, for example, connector 108 comprises a single MMCX connector located in one corner of the RF portion of core module 102.

[032] A second antenna may be required depending on what advanced features are supported by assembly 100. For example, if assembly 100 supports Bluetooth™ or Global Positioning System (GPS) applications, then a second antenna may be needed. A secondary antenna connection can be located elsewhere and is not necessarily limited by the location of antenna connector 108. Preferably, however, assembly 100 also comprises a standard location for any secondary antenna connector that may be required.

As with antenna connector 108, a standard location for secondary antenna can save time and cost.

b. The Baseband Section

[033] Figure 3 illustrates an example embodiment of a baseband section 300. Baseband section 300 comprises a Control Processing Unit (CPU) and/or a Digital Signal Processor (DSP), such as CPU/DSP 302, which controls the operation of baseband section 300. Baseband section 300 also includes a memory 304 for storing application software used by CPU/DSP 302 to operate baseband section 300. Memory 304 can also store data used by baseband section 300. Baseband section 300 can also includes a voice codec 306. Voice codec 306 is used to encode and decode voice information. Therefore, if assembly 100 is capable of communicating voice as well as data, voice codec 306 can be included in baseband section 300.

[034] Baseband section 300 is responsible for communicating with a host device, such as host device 114. Baseband section 106 takes information from host device 114 and encodes it into a baseband signal that is passed to an RF section, such as RF section 104, for transmission over a communication channel to another device. Conversely, baseband section 300 also takes baseband signals from RF section 104 and decodes them into signals that can be sent to host device 114. In order to communicate with host device 114, baseband section 300 must be capable of implementing a software protocol that host device 114 can interpret. Preferably, a wireless modem assembly 100 designed in accordance with the systems and methods for multi-platform wireless modem, and in particular with the standardization principles discussed above, implements a standard

host communication protocol for communication with a host device 114. Preferably, the host communication software protocol primarily comprises an AT command set that includes both technology-agnostic as well as technology specific AT commands. Again, such standardization saves design time and cost, because each core module 102 can be designed to implement the same software protocol.

[035] Communication with host device 114 is preferably controlled by a communication device, such as a Universal Asynchronous Receiver Transmitter (UART) 308 as illustrated in figure 3. Further, the software used by baseband section 300 to implement the host communication protocol for communicating with host device 114 is preferably stored in memory 304.

[036] The encoding and decoding of baseband signals communicated between baseband section 300 and RF section 104 is performed by CPU/DSP 302. In order to correctly encode and decode the baseband signals, baseband section 300 must be configured to support the appropriate wireless communication protocol for the wireless communication system. The software used by baseband section 300 to implement the communication protocol is also preferably stored in memory 304. The appropriate communication protocol is dictated by, or is part of, the air interface standard being implemented. Some example communication protocols that can be supported are CDPD, Metricom/Ricochet2, General Packet Radio Service (GPRS)/GPS, EDGE, CDMA 1xRTT (Real Time Technology), CDMA 3xRTT, and CDMA HDR (High Data Rate).

[037] Significantly, because of the standardization employed by the systems and methods for a multi-platform wireless modem, reconfiguration of a wireless modem

assembly 100 to support a new communication protocol can be done quickly, efficiently, and with very little customization, merely by replacing core module 102, and possibly the antenna included in assembly 100. Alternatively, in some embodiments core module 102 can be reconfigured for a new communication protocol via a software reconfiguration due to the implementation of the standardization principles discussed. Again this can significantly streamline the manufacturing process and can even allow over the air reconfiguration for units in the field.

[038] The design of baseband section 300 can also include advanced feature support 310 that allows wireless modem assembly 100 to capture applications such as MPEG audio layer 3 (MP3), Moving Picture Experts Group (MPEG)-4, Musical Instrument Digital Interface (MIDI), Digital-Voice for voice recognition, voice-to-text and text-to-voice conversion, voice memo/recording, GPS, Bluetooth™/W-PAN (Wireless-Personal Area Network), Wireless-Local Area Network (WLAN), etc. Figure 3 shows, schematically, the support for future advanced features. The objective of figure 3, in this regard, is to demonstrate that when an advanced feature 110 is implemented, baseband section 300 makes available the data appropriate to this "feature" to CPU/DSP 302. Further, appropriate application software stored, for example, in memory 304 can then enable CPU/DSP 302 to support the advanced feature.

[039] From the perspective of interface 112, in figure 1, these advanced features are preferably supported by the connection scheme with host device 114. Preferably, the advanced features are supported in interface 112 only to the extent that they do not require an excessive number of dedicated hardware interface signals. To ensure adequate

support for advanced features, however, interface 112 preferably includes at least limited future flexibility in the form of reserved or undefined (NoConnect/NC) interface signals. Another option available for assembly 100 implementations is the addition of hardware external to assembly 100 that can route the "advanced feature" data across interface 112 to host device 114. This is discussed in detail in the next section.

[040] Therefore, implementing the standardization principles described in designing core module 102 allows the manufacturing process to be streamlined, thus saving time and cost. Reconfiguration of fielded units is also easier and less time consuming. Notably, implementation of the standardization principles can even allow for software reconfiguration of wireless modem assembly 100 either in the factory or in the field. This can have important cost savings implications. For example, in the factory, the manufacturing process an be streamlined by designing one core module 102, and therefore one assembly 100. At the end of the process, each core module 102, or assembly 100, can be configured for the appropriate application via a software configuration step. Similarly, fielded assemblies can be quickly and easily reconfigured by interfacing them to a computer and downloading the appropriate software. In some embodiments, over the air reconfiguration can also be implemented.

2. Modem Interface Device

[041] Figure 4 illustrates a wireless modem assembly 400 that includes a wireless interface device 406 that interfaces interface 112 and host device 114. Core module 102 communicates to host device 114 through interface 112 as before, however, modem interface device 406 can be required for a variety of reasons. One reason device 406 can

be required is to convert from the standardized interface of interface 112 to a host specific interface for host device 114. Another reason is that device 406 can be used to add to or expand the functionality of assembly 400, which is more clearly demonstrated by the example embodiment of a modem interface device 500 illustrated in figure 5. Modem interface device 500 comprises UART 502, memory 504, CPU/DSP 506, and advanced feature set 508.

[042] Several advantages accrue as a result of including modem interface device 500. For example, as data services continue to evolve, modem designs will likely not have sufficient CPU/DSP processing power for execution of the extensive user/application code that will be required. This is primarily due to the overhead involved in simply managing the air interface. Further, in certain embodiments extensive processing power within assembly 400 is undesirable for reasons of cost efficiency. Therefore, additional functionality including processing, CPU/DSP 506, and/or application memory 504 can be provided by including them in a modem interface device 500.

[043] Additionally, if extensive application processing is performed within assembly 400 itself, the execution speed may be impacted by a relatively slow serial interface between assembly 400 and host 408. This can be another reason to include a modem interface device, such as device 500. For example, even if the fastest Universal Serial Bus (USB) speeds, e.g., 12 Mbps of USB 1.1, are available, execution speed can still be impacted. Therefore, additional CPU/DSP 506 and/or memory 504 added in a modem interface device 500 can be used to prevent a relatively slow serial interface at the output of assembly 400 from precluding more powerful implementations.

[044] Such "co-processing" capability is a powerful extension of the capabilities of assembly 400. For example, if an even higher-speed serial connection is required between assembly 400 and host device 408, then the compatible USB 2.0 interface can, for example, be supported by including the appropriate resources in modem interface device 500. Moreover, instead of including support for advanced features 110 in assembly 100, such support can be included in modem interface device 500 as illustrated by advanced feature support 508.

[045] Thus, a modem interface device, such as devices 406 and 500, can allow for a streamlined manufacturing process even when particular applications require specialized features and/or resources. Wireless modem assembly 400 can still be designed in accordance with the standardization principles discussed above, which will provide all of the benefits described, and any application specific features can be incorporated into a modem interface device. Therefore, the manufacturing process for different assemblies 400 can be substantially the same, the only difference being what type of modem interface device is used. Support for varying features can of course result in differences in the application software as well, but accommodating these differences through the combination of application specific hardware and a specific modem interface device is much easier than accommodating them through design differences in assembly 400.

3. Power Management

[046] Another aspect of the standardization principles discussed above is power management. Preferably, therefore, baseband section 106 also implements a standard power management scheme. To support this power management scheme, interface 112

preferably includes a standard power supply from host device 114. For example, a nominal 3.6V supply supporting 3.3V LVTTL signaling can be used. In addition, there is preferably a standby power source from host device 114 to assembly 100.

[047] Preferably, the power management scheme is divided into three categories: network (air-interface) based, host (operating system) based, and internal-modem-specific based. Network power management is specific to the air-interface standard, and includes power saving methods such as the Quick Paging channel in a CDMA2000™ System. An example of host/operating-system based power management is that which applies to the Personal Computing Memory Card Interface Association (PCMCIA) standards, which include reference to the Advanced Configuration and Power Interface (ACPI) standard. An example of an internal modem-specific power savings feature may be shutting off certain parts of the assemblies electronics based on rules not covered by network or host protocols, or as specifically demanded by the user and implemented by modem assembly 100.

[048] Again, the design and manufacture of assembly 100 can be streamlined by implementing the standardized power management described above because it avoids the burden of incorporating differing power management schemes into assembly 100. It also simplifies the design of standard interface 112, because it does not need to support a variety of power management signals and protocols. Nor does it need to be changed or reconfigured to support such differing signals and protocols.

4. SIM and/or R-UIM support

[049] As illustrated in figure 1, support for the GSM Subscriber Identity Module (SIM) card 116 can be provided within assembly 100. Interface 112 can accommodate this support depending on whether SIM card 116 is "external" or "internal". Thus, the SIM 116 can take the following forms:

i. *External.* The SIM signals are sent to host device 114, which manages SIM card 116

ii. *Internal.* Assembly 100 is provided with an "internal" SIM module 116, extracting SIM signals from interface 112 and driving a SIM cardholder that is preferably mounted on assembly 100.

[050] Further, support for the CDMA/ANSI-136 Replaceable Universal Identity Module (R-UIM) (not shown) is also preferably provided via shared use of the SIM signals of interface 112. The R-UIM standard is backward compatible with the SIM standard.

5. Standard form factor

[051] Another area of standardization that is preferably included in wireless modem assemblies designed in accordance with the systems and methods for a multi-platform wireless modem is the form factor of assembly 100. Preferably, each wireless modem assembly 100 is designed in accordance with one of two standardized form factors. In the first of these form factors, the width of the modem is approximately 54mm, the length is approximately 72.9mm, and the thickness is approximately 5.6mm. The second standard form factor is intended to be compatible with the compact flash form factor. Accordingly, this form factor has a width of approximately 42.8mm, a length of

approximately 36.4mm, and a thickness of approximately 5.6mm. It should be noted, however, that some or all of these dimensions may need to change depending on the requirements of a particular implementation. Further, other standardized form factors are clearly contemplated and within the scope of the SIM's described herein. It is also preferable that each of these standard form factors also specifies a location for a connector that implements interface 112.

[052] Again, by standardizing the form factor, the manufacturing process can be made less costly and time consuming. In addition, upgrading or changing wireless modem assemblies 100 is made easier because the new modem will have the same form factor and host interface 112. Thus, if a user wanted to upgrade his wireless data service, for example, the user could simply install the requisite software and then simply swap the old assembly 100 for the appropriate new assembly 100. This makes upgrading, or migrating from one technology to another easier and less costly, which is a benefit to consumers, system integrators, and manufacturers.

6. Standard Interface

[053] Preferably, assembly 100 comprises a standard interface 112. In other words, regardless of what type of device assembly 100 is interfacing with, one aspect of the systems and methods for a multi-platform wireless modem is that interface 112 can use a standard interface. Thus, the design of wireless modem assemblies 110 is simplified if designed in accordance with the systems and methods for a multi-platform wireless modem.

[054] As noted, because there are many possible host devices, not all of which are compatible with interface 112, wireless modem assembly 100 may need a modem interface device 500 to convert interface 112 to an interface required by host device 114. Moreover, some devices 114 may require that a host-specific interface be used. For example, in wireless modem assemblies 100 designed for insertion into a PCMCIA slot, standard interface 112 can be replaced by the standard PCMCIA interface. Alternatively, a modem interface device 500 can be used to convert interface 112 to the PCMCIA interface.

[055] Standard interface 112 includes several serial data interfaces for interfacing a host device 114 to a wireless modem assembly 100. These serial data interfaces are illustrated, interfacing host device 114 and modem assembly 600, as serial data interface 608, 610, and 612 in figure 6. Preferably, interface 608 is a primary Recommended Standard -232 (RS232) serial data interface, known as Port A. Port A preferably supports the following signal set: TXD, RXD, CTS, RTS, DTR, DSR. If interface 112 supports serial data interface 612, then support for Port A is desired but not required.

[056] Additionally, interface 112 preferably supports a secondary RS232 serial data interface, known as Port B. Port B preferably comprises the two signals TXD2 and RXD2. Port B can be used within the module in one of two ways. The standard use of 610a, designated Port B1, is for internal peripheral device 606 communication. This can be used, for example, for communication with a device such as a GPS receiver. In this case, the signals TXD2 and RXD2 are signals internal to wireless modem assembly 600 and do not appear on interface 112. An alternate use comprises interfaced 610b,

designated Port B2, utilizes the same two signals and forms an interface to host device 602. In this case, the signals can be multiplexed with two General Purpose Input/Output (GPIO), which are discussed below. Port B2 or Port B1 preferably supports a minimum rate of 38.4 kbps, and a rate of 115 kbps is preferable.

Further, interface 112 preferably includes optional support for a USB serial data interface, known as Port C 116. Support for Port C is provided via two signals included in interface 112, USB+ and USB-, which form a differential signal pair. Preferably, Port C supports a minimum rate of 2.5 Mbps, which is necessary, for example, to support the IMT-2000/3G data rates. If Port C is present, it preferably forms the primary communication interface for WAN data between modem assembly 600 and host 114. If there is no Port C support, then by default Port A serves as the WAN data communication transport.

[057] Preferably, Port A and/or Port C support the maximum serial data rates required by the communication protocols implemented by baseband section 106, plus a nominal 10% overhead. If Port A cannot support the desired rate, then Port C can be selected. Further, If Port C supports the maximum data rates, then Port A need only support a minimum rate of 38.4 kbps, but a rate of 115 kbps is preferable.

[058] In addition to serial data interfaces 608, 610, and 612, interface 112 also preferably includes the following interfaces between host device 102 and modem 600: power and ground interfaces to modem assembly 600, a wireless modem status interface, at least one ADC input to modem assembly 600, a power standby input to modem 600, a JTAG interface between host device 114 and modem assembly 600, and a GPIO

interface, comprising a plurality of GPIO inputs/outputs. The GPIO interface preferably comprises as many GPIO signals as possible within the constraint of a reasonable connector total pin count.

Interface 112 also preferably provides a SIM interface configured to provide a data communication interface between host device 114, or wireless modem assembly 604, and a SIM card (not shown) included in wireless modem assembly 600.There is also preferably an audio interface configured to provide a buzzer output to host device 114, a speaker output to host device 114, a microphone input to wireless modem assembly 600, and a digital voice interface between host device 114 and wireless modem assembly 600.

Other interfaces or signals that can be included in interface 112 include: support for at least one ADC input, support for a "standby" power source from the host 602 to modem assembly 600, and support for a JTAG (IEEE 1149) interface.

[059] Interface 112 is typically embodied in a standard connector. Preferably, the connector is a 70-pin connector. 70-pins allows enough pins to cover the features described, with an adequate amount of pins left over for future expansion. One example connector that can be used is SMK's CPB7270-1211 (Mtype) connector. The following tables provide an example pin description for interface 112 implemented in a 70-pin connector. Note that the actual pin numbers are by way of example only.

TABLE 1 Pin Assignments by Function

Basic function interface

Pin Number	***Name***	***Direction (with respect to the modem)***	***Power-on Reset State***	***Description***
28,29,30,31	VCC1	Power	-	Power Supply Connection to the Modem for all Circuitry Except for the RF Power Amplifier
18,19,20,21,22,23,24,25	VCC2	Power	-	Power Supply Connection to the Modem for the RF Power Amplifier Only
6,8,9,11,17,26,27,42,48,60,61,70	GND	Power	-	Modem Signal and Chassis Ground
59	PWR_IND	Output	-	Power Indicator: HIGH: Indicates that the modem is on LOW: Indicates that the modem is off
57	SM_IND	Output	-	Sleep Mode Indicator: HIGH: Indicates that the Modem is on LOW: Indicates that the modem is off
58	WKUP	Input	-	Wake up Input: (Active High Pulse) Refer to Applications information for more details.
56	DTM	Input	-	Data to Modem: (3.3V Logic Level) In RS-232 terms, this is called "TXD"
55	DFM	Output	-	Data From Modem: (3.3V Logic Level) In RS-232 terms, this is called "RXD"
51	RTS	Input	-	Ready to Send: (3.3V Logic Level)
52	CTS	Output	-	Clear to Send: (3.3V Logic Level)
54	DTR	Input	-	DTE Ready: (3.3V Logic Level)
53	DSR	Output	-	DCE Ready: (3.3V Logic Level)
49	GPIO1	Bi-directional	Input with Pullup	General Purpose Configurable Input or Output: Refer to the AT command set for the Default State
50	GPIO2	Bi-directional	Input with Pullup	General Purpose Configurable Input or Output: Refer to the AT command set for the Default State

Pin Number	*Name*	*Direction (with respect to the modem)*	*Power-on Reset State*	*Description*
47	GPIO3	Bi-directional	Input with Pulldown	General Purpose Configurable Input or Output: Refer to the AT command set for the Default State
46	GPIO4	Bi-directional	Input with Pullup	General Purpose Configurable Input or Output: Refer to the AT command set for the Default State
45	GPIO5	Bi-directional	Input with Pulldown	General Purpose Configurable Input or Output: Refer to the AT command set for the Default State
44	GPIO6	Bi-directional	Input with Pullup	General Purpose Configurable Input or Output: Refer to the AT command set for the Default State
5	ADC_IN1	Analog Input	ADC Input	ADC Input: This pin is connected to one channel of an ADC.

SIM Interface

Pin Number	*Name*	*Direction (with respect to the modem)*	*Power-on Reset State*	*Description*
36	VCC_SIM (C1)	Power	-	Power Supply For the SIM/R-UIM module
34	DATA_SIM (C7)	Input/Output	-	Data to and From the SIM/R-UIM module
32	CLK_SIM (C3)	Input	-	Clock to the SIM/R-UIM
39	RST_SIM (C2)	Input	-	Reset to the SIM/R-UIM
37	SPARE_SIM (C8)	TBD	-	Spare SIM/R-UIM signal (future)
35	SPARE_SIM (C4)	TBD	-	Spare SIM/R-UIM signal (future)
33	SIM_NOT_IN	Input	-	Indicator for SIM/R-UIM presence

Audio Interface

Pin Number	*Name*	*Direction (with respect to the modem)*	*Power-on Reset State*	*Description*
2	MIC_INP	Input	-	Positive differential input for the microphone (analog voice)
4	MIC_INN	Input	-	Negative differential input for the microphone (analog voice)
3	SPKR_OUTP	Output	-	Positive differential output for the speaker (analog voice)

1	SPKR_OUTN	Output	-	Positive differential output for the speaker (analog voice)
15	DIGVOICE_TX	Output	-	Digital Serial Voice Output
13	DIGVOICE_RX	Input	-	Digital Serial Voice Input
12	DIGVOICE_CLK	Output	-	Digital Voice Clock
10	DIGVOICE_FRM	Output	-	Digital Voice Frame
16	BUZZER	Output	-	Buzzer Output

Miscellaneous

Pin Number	***Name***	***Direction (with respect to the modem)***	***Power-on Reset State***	***Description***
14	VCC_STANDBY	Power	-	Input Power for Standby of the Modem
7	ADC_IN2	Input	-	ADC Input: This pin is connected to one channel of an ADC.
43	GPIO7	Bi-directional	Input with Pullup	General Purpose Configurable Input or Output
40	GPIO8	Bi-directional	Input with Pullup	General Purpose Configurable Input or Output:
41	GPIO9	Bi-directional	Input with Pulldown	General Purpose configurable Input or Output
38	GPIO10	Bi-directional	Input with Pulldown	General Purpose Configurable Input or Output:
62,63,64,65,66,67,68,69	Future	TBD	TBD	TBD

TABLE II Pin Assignments by Pin Number

Pin Number	***Name***	***Direction (with respect to the modem)***	***Power-on Reset State***	***Description***
1	SPKR_OUTN	Output	-	Positive differential output for the speaker (analog voice)
2	MIC_INP	Input	-	Positive differential input for the microphone (analog voice)
3	SPKR_OUTP	Output	-	Positive differential output for the speaker (analog voice)
4	MIC_INN	Input	-	Negative differential input for the microphone (analog voice)

Pin Number	***Name***	***Direction (with respect to the modem)***	***Power-on Reset State***	***Description***
5	ADC_IN1	Analog Input	ADC Input	ADC Input: This pin is connected to one channel of an ADC.
6	GND	Power	-	Modem Signal and Chassis Ground
7	ADC_IN2	Input	-	ADC Input: This pin is connected to one channel of an ADC.
8	GND	Power	-	Modem Signal and Chassis Ground
9	GND	Power	-	Modem Signal and Chassis Ground
10	DIGVOICE_FRM	Output	-	Digital Voice Frame
11	GND	Power	-	Modem Signal and Chassis Ground
12	DIGVOICE_CLK	Output	-	Digital Voice Clock
13	DIGVOICE_RX	Input	-	Digital Serial Voice Input
14	VCC_STANDBY	Power	-	Input Power for Standby of the Modem
15	DIGVOICE_TX	Output	-	Digital Serial Voice Output
16	BUZZER	Output	-	Buzzer Output
17	GND	Power	-	Modem Signal and Chassis Ground
18	VCC2	Power	-	Power Supply Connection to the Modem for the RF Power Amplifier Only
19	VCC2	Power	-	Power Supply Connection to the Modem for the RF Power Amplifier Only
20	VCC2	Power	-	Power Supply Connection to the Modem for the RF Power Amplifier Only
21	VCC2	Power	-	Power Supply Connection to the Modem for the RF Power Amplifier Only
22	VCC2	Power	-	Power Supply Connection to the Modem for the RF Power Amplifier Only
23	VCC2	Power	-	Power Supply Connection to the Modem for the RF Power Amplifier Only
24	VCC2	Power	-	Power Supply Connection to the Modem for the RF Power Amplifier Only
25	VCC2	Power	-	Power Supply Connection to the Modem for the RF Power Amplifier Only
26	GND	Power	-	Modem Signal and Chassis

Pin Number	*Name*	*Direction (with respect to the modem)*	*Power-on Reset State*	*Description*
				Ground
27	GND	Power	-	Modem Signal and Chassis Ground
28	VCC1	Power	-	Power Supply Connection to the Modem for all Circuitry Except for the RF Power Amplifier
29	VCC1	Power	-	Power Supply Connection to the Modem for all Circuitry Except for the RF Power Amplifier
30	VCC1	Power	-	Power Supply Connection to the Modem for all Circuitry Except for the RF Power Amplifier
31	VCC1	Power	-	Power Supply Connection to the Modem for all Circuitry Except for the RF Power Amplifier
32	CLK_SIM (C3)	Input	-	Clock to the SIM/R-UIM
33	SIM_NOT_IN	Input	-	Indicator for SIM/R-UIM presence
34	DATA_SIM (C7)	Input/Output	-	Data to and From the SIM/R-UIM module
35	SPARE_SIM (C4)	TBD	-	Spare SIM/R-UIM signal (future)
36	VCC_SIM (C1)	Power	-	Power Supply For the SIM/R-UIM module
37	SPARE_SIM (C8)	TBD	-	Spare SIM/R-UIM signal (future)
38	GPIO10	Bi-directional	Input with Pulldown	General Purpose Configurable Input or Output: Refer to the AT command set for the Default State
39	RST_SIM (C2)	Input	-	Reset to the SIM/R-UIM
40	GPIO8	Bi-directional	Input with Pullup	General Purpose Configurable Input or Output: Refer to the AT command set for the Default State
41	GPIO9	Bi-directional	Input with Pulldown	General Purpose Configurable Input or Output: Refer to the AT command set for the Default State
42	GND	Power	-	Modem Signal and Chassis Ground
43	GPIO7	Bi-directional	Input with	General Purpose

Pin Number	Name	Direction (with respect to the modem)	Power-on Reset State	Description
			Pullup	Configurable Input or Output: Refer to the AT command set for the Default State
44	GPIO6	Bi-directional	Input with Pullup	General Purpose Configurable Input or Output: Refer to the AT command set for the Default State
45	GPIO5	Bi-directional	Input with Pulldown	General Purpose Configurable Input or Output: Refer to the AT command set for the Default State
46	GPIO4	Bi-directional	Input with Pullup	General Purpose Configurable Input or Output: Refer to the AT command set for the Default State
47	GPIO3	Bi-directional	Input with Pulldown	General Purpose Configurable Input or Output: Refer to the AT command set for the Default State
48	GND	Power	-	Modem Signal and Chassis Ground
49	GPIO1	Bi-directional	Input with Pullup	General Purpose Configurable Input or Output: Refer to the AT command set for the Default State
50	GPIO2	Bi-directional	Input with Pullup	General Purpose Configurable Input or Output: Refer to the AT command set for the Default State
51	RTS	Input	-	Ready to Send: (3.3V Logic Level)
52	CTS	Output	-	Clear to Send: (3.3V Logic Level)
53	DSR	Output	-	DCE Ready: (3.3V Logic Level)
54	DTR	Input	-	DTE Ready: (3.3V Logic Level)
55	DFM	Output	-	Data From Modem: (3.3V Logic Level) In RS-232 terms, this is called "RXD"

Pin Number	Name	Direction (with respect to the modem)	Power-on Reset State	Description
56	DTM	Input	-	Data to Modem: (3.3V Logic Level) In RS-232 terms, this is called "TXD"
57	SM_IND	Output	-	Sleep Mode Indicator: HIGH: Indicates that the Modem is on LOW: Indicates that the modem is off
58	WKUP	Input	-	Wake up Input: (Active High Pulse) Refer to Applications information for more details.
59	PWR_IND	Output	-	Power Indicator: HIGH: Indicates that the modem is on LOW: Indicates that the modem is off
60	GND	Power	-	Modem Signal and Chassis Ground
61	GND	Power	-	Modem Signal and Chassis Ground
62	Future	TBD	TBD	TBD
63	Future	TBD	TBD	TBD
64	Future	TBD	TBD	TBD
65	Future	TBD	TBD	TBD
66	Future	TBD	TBD	TBD
67	Future	TBD	TBD	TBD
68	Future	TBD	TBD	TBD
69	Future	TBD	TBD	TBD
70	GND	Power	-	Modem Signal and Chassis Ground